Simulations of the Eastern North Pacific Intraseasonal Variability in CMIP5 GCMs

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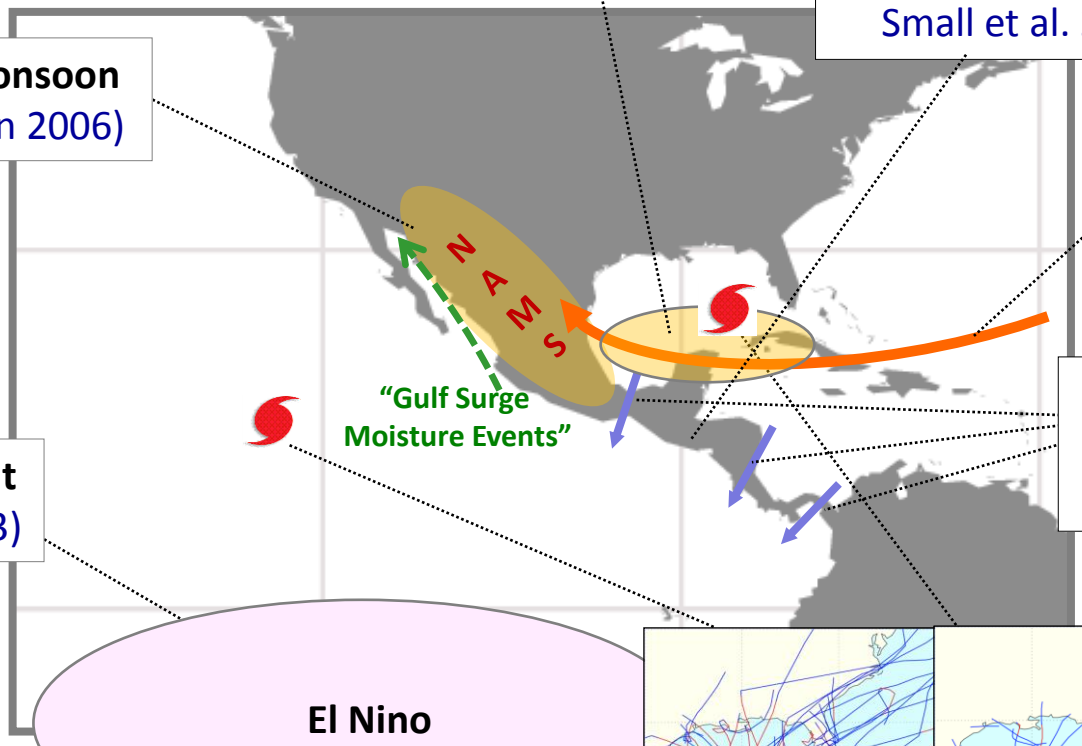
I. Introduction - Regional Impacts of ISV over the Eastern Pacific



Caribbean Precipitation
(Martin & Schumacher 2011)

Central America Mid-Summer Drought
(Magana et al. 1999; Small et al. 2007)

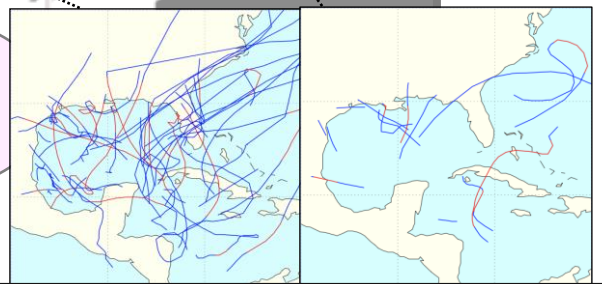
North American Monsoon
(Lorenz & Hartmann 2006)

Caribbean Sea LLJ
(Serra et al. 2010)

Gap Winds
(Maloney & Esbensen 2003)

El Nino Development
(Vintzileos et al. 2003)

El Nino



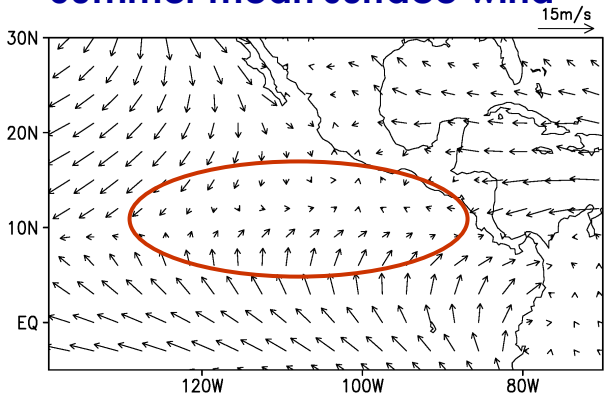
Tropical Cyclone
Maloney & Hartmann (2000a,b)
Higgins & Shi (2001)

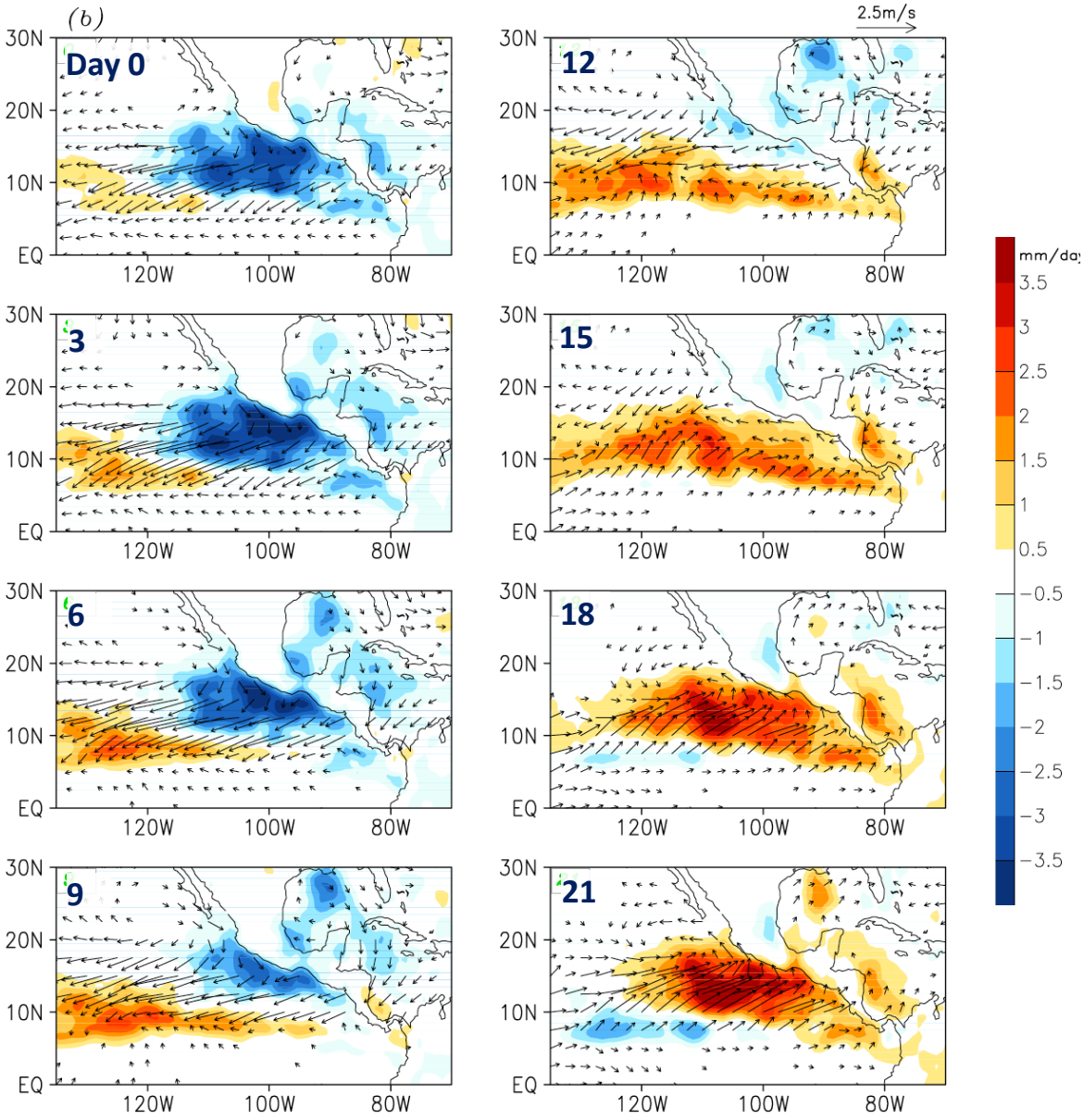
Evolution of the leading ISV mode (40-day mode) over the ENP

Shading: Rainfall
Vectors: Surface wind

- Signals from west;
- Enhanced convection ↔ westerly wind anomalies;
- Critical role of latent heat flux for the ENP ISV (Malonery & Esbensen 2003)

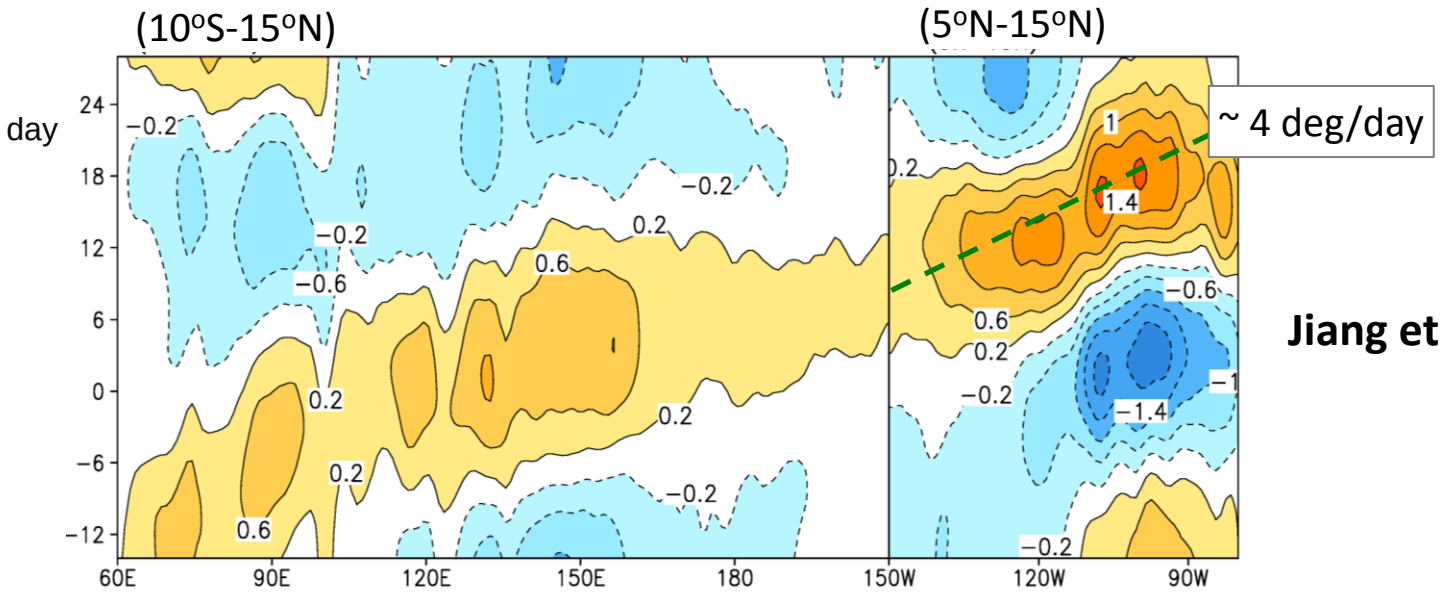
Summer mean surface wind





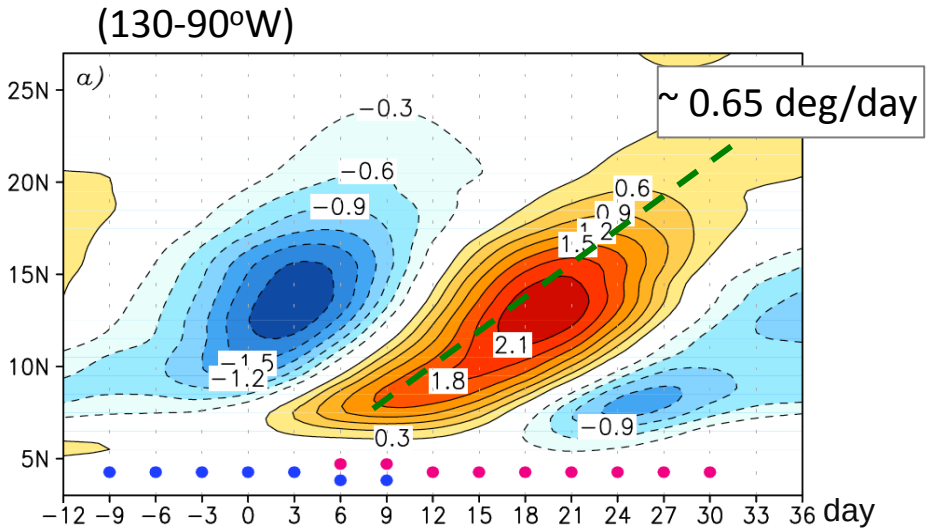
Jiang & Waliser (2008)

Eastward Propagation of ENP ISV mode



Jiang et al. (2011)

Northward Propagation



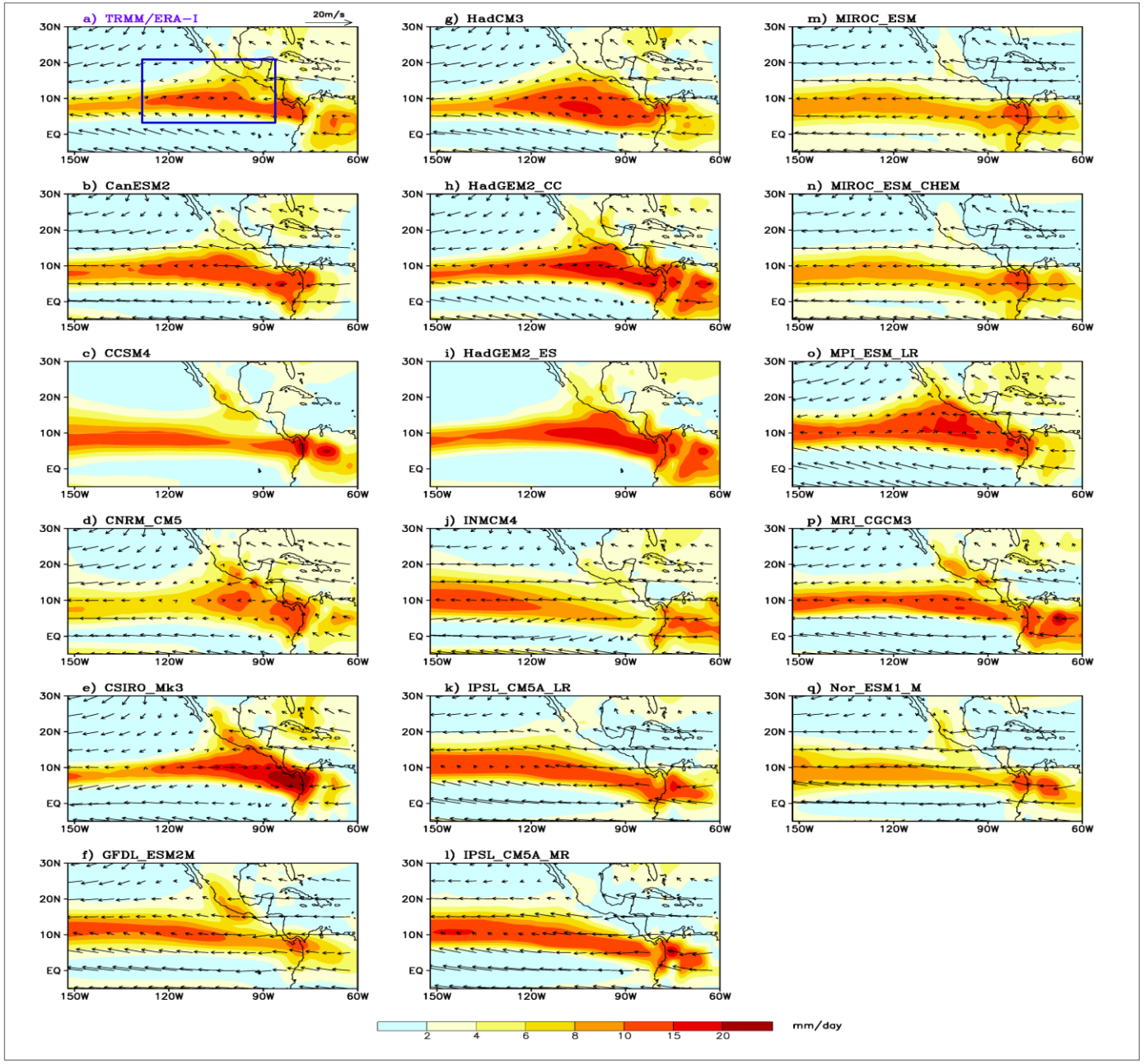
Jiang & Waliser (2008)

II. GCM Fidelity in Representing ENP ISV

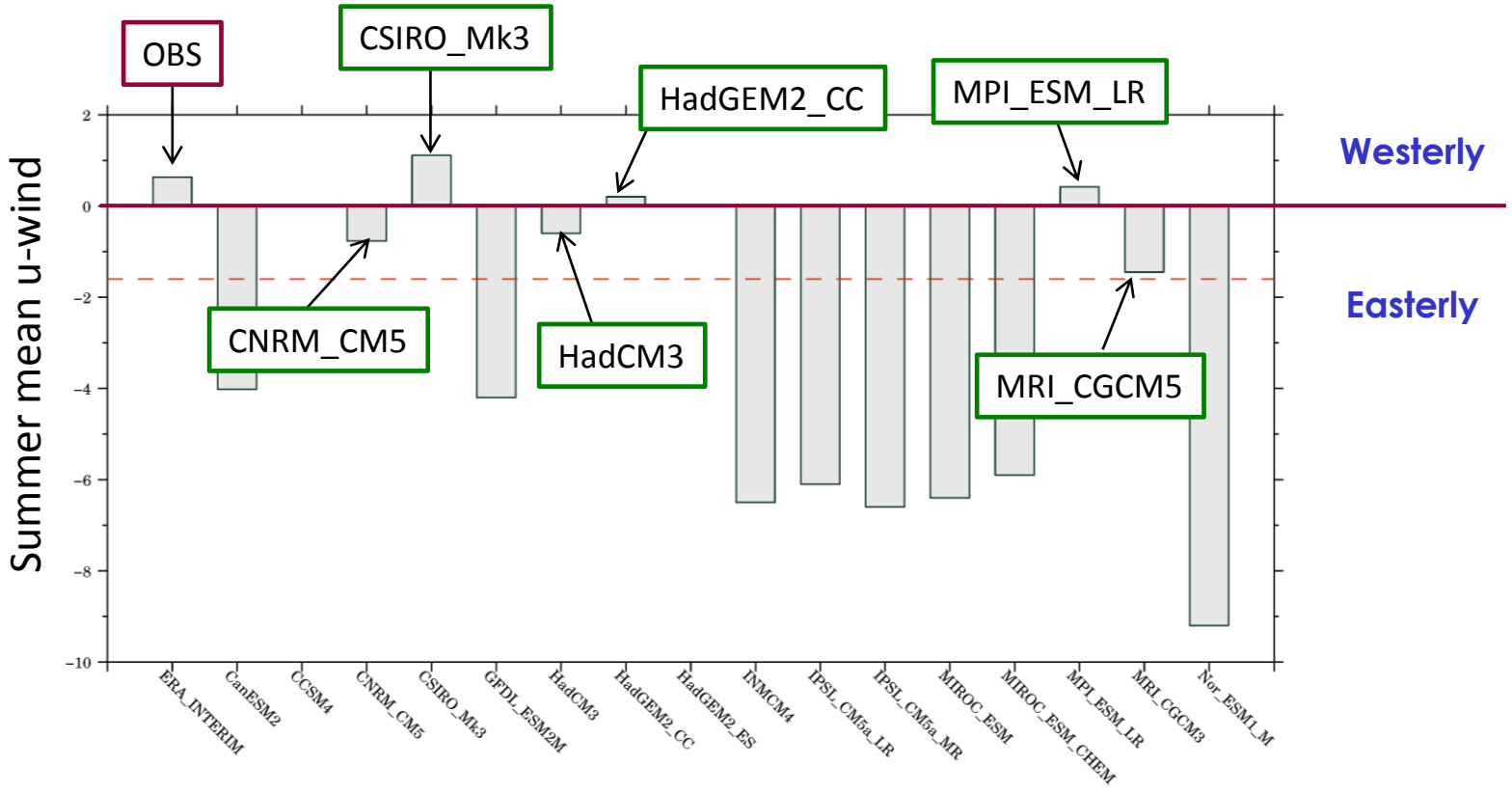
CMIP5 models analyzed in this study

Model Name	Modeling Center	Horizontal Resolution of Atmospheric Model (lon × lat deg)	Scenario
CanESM2	Canadian Center for Climate Modeling and Analysis	2.8 × 2.8	"historical"
CCSM4	US National Center for Atmospheric Research	1.25 × 1	"historical" , "RCP8.5"
CNRM-CM5	National Centre for Meteorological Research, France	1.4 × 1.4	"historical"
CSIRO-MK3	Commonwealth Scientific and Industrial Research Organization /Queensland Climate Change Centre of Excellence, AUS	1.8 × 1.8	"historical"
GFDL-ESM2M	NOAA Geophysical Fluid Dynamics Laboratory	2.5 × 2.0	"historical"
HadCM3 HadGEM2-CC HadGEM2-ES	UK Met Office Hadley Centre	3.7 × 2.5 1.8 × 1.25 1.8 × 1.25	"historical" "historical", "RCP8.5" "historical", "RCP8.5"
INMCM4	Institute for Numerical Mathematics, Russia	2 × 1.5	"historical"
IPSL-CM5A-LR IPSL-CM5A-MR	Institute Pierre Simon Laplace, France	3.75 × 1.8 2.5 × 1.25	"historical"
MIROC-ESM MIROC-ESM-CHEM	Atmosphere and Ocean Research Institute (The University of Tokyo), National Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and Technology, Japan	1.4 × 1.4	"historical"
MPI-ESM-LR	Max Planch Institute for Meteorology, Germany	1.9 × 1.9	"historical", "RCP8.5"
MRI-CGCM3	Meteorological Research Institute, Japan	1.1 × 1.1	"historical"
NorESM1-M	Norwegian Climate Center, Norway	2.5 × 1.9	"historical"

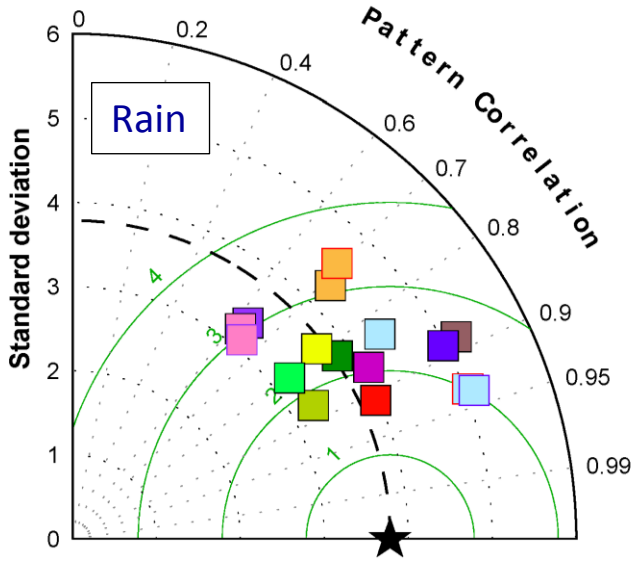
Summer Mean Rainfall and 850hPa Winds

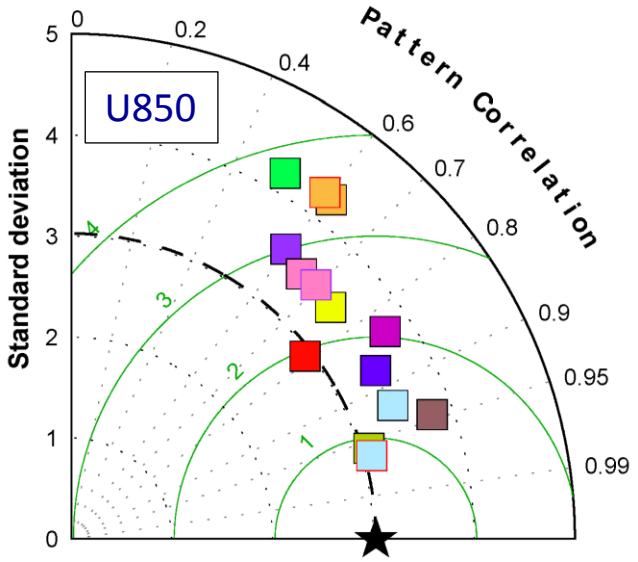


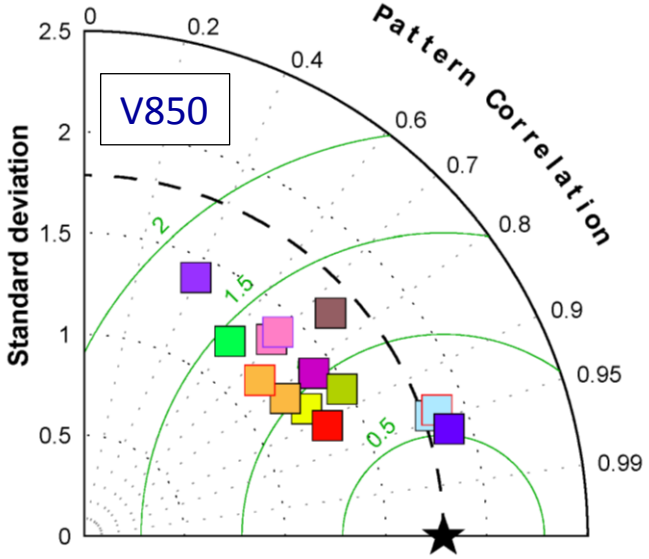
Summer mean zonal wind over the ENP warm pool

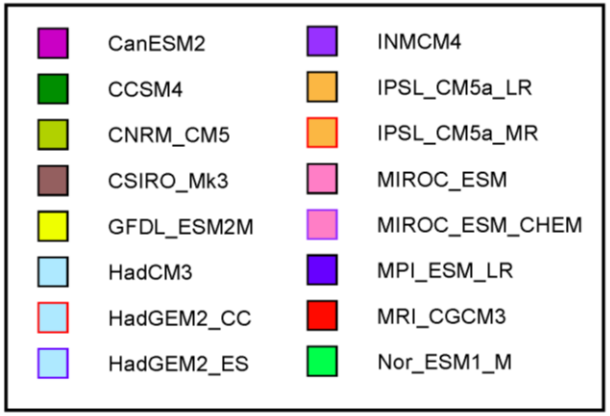


Taylor Diagrams for Summer mean rainfall, 850hPa winds

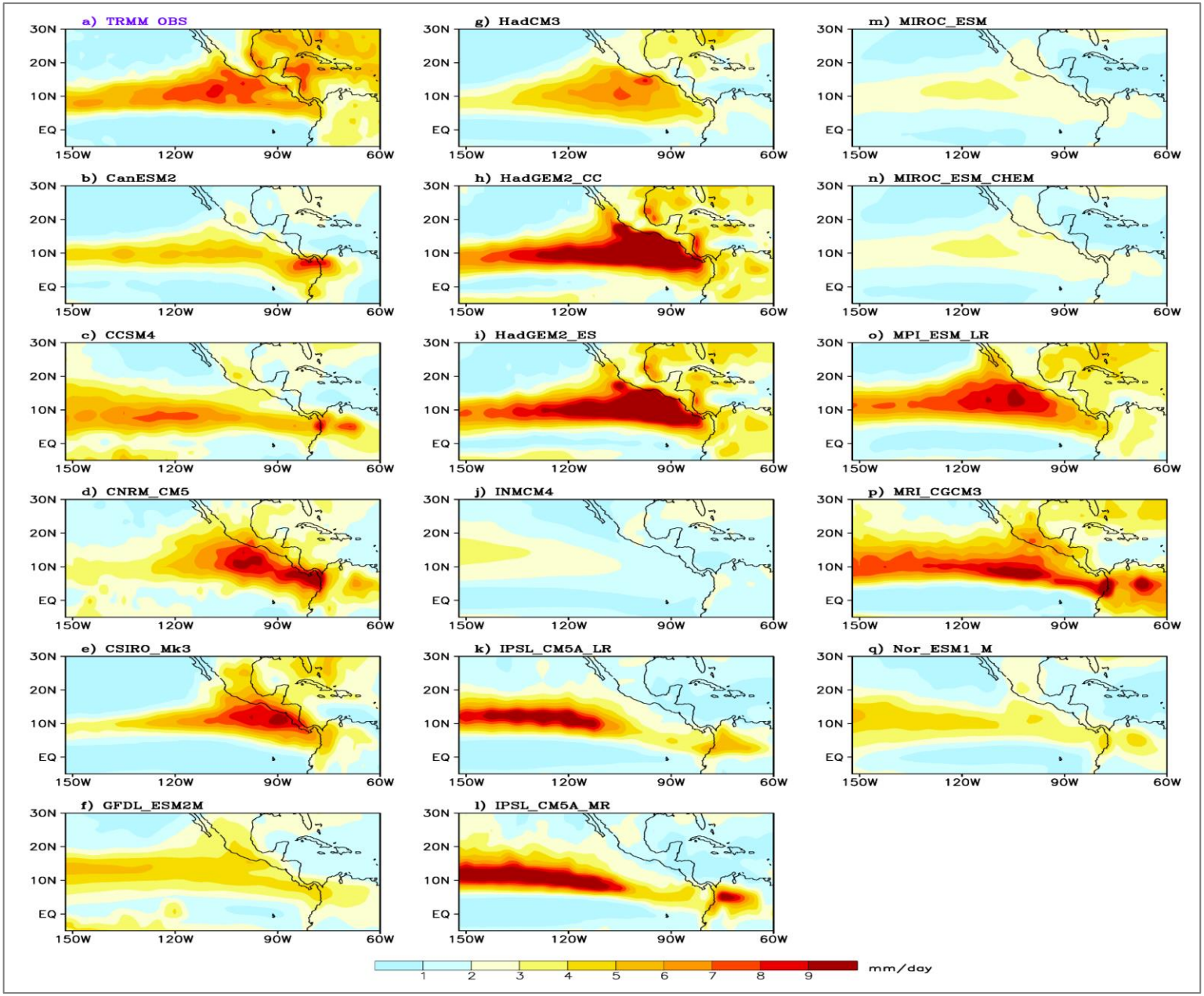








STD of 10-90-day filtered rainfall (May-September)



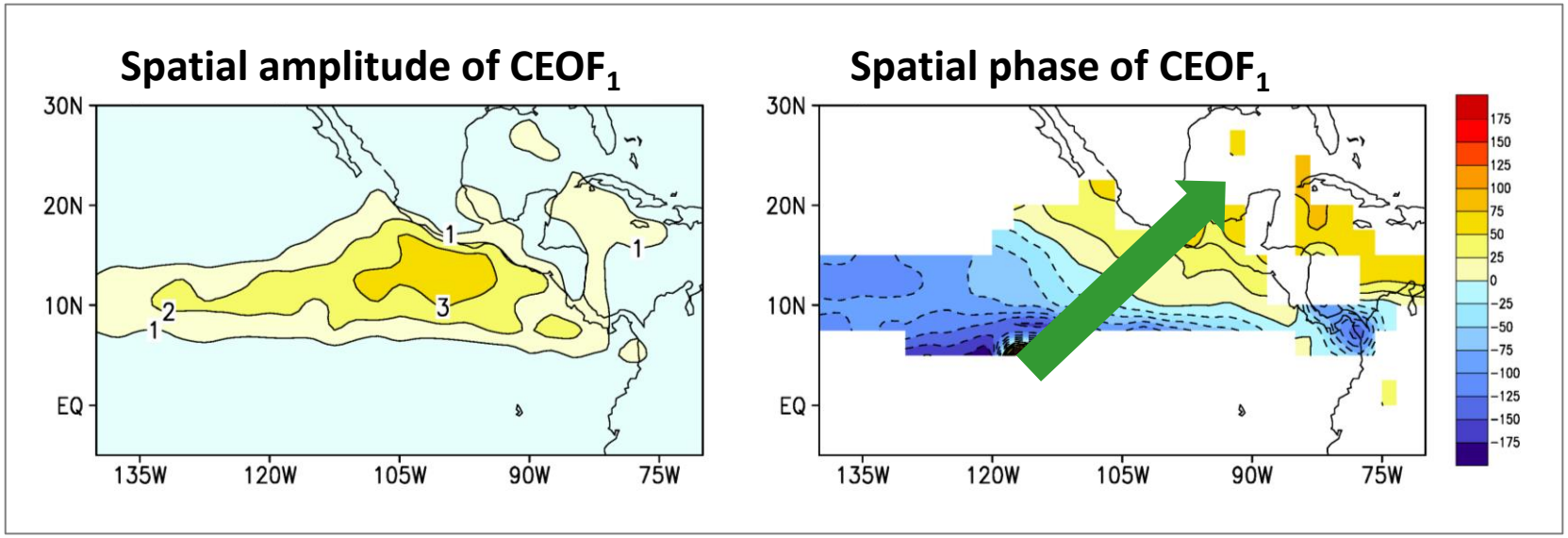
Complex EOF (CEOF) analysis

(Barnet 1983; Horel 1984; Maloney et al . 2008)

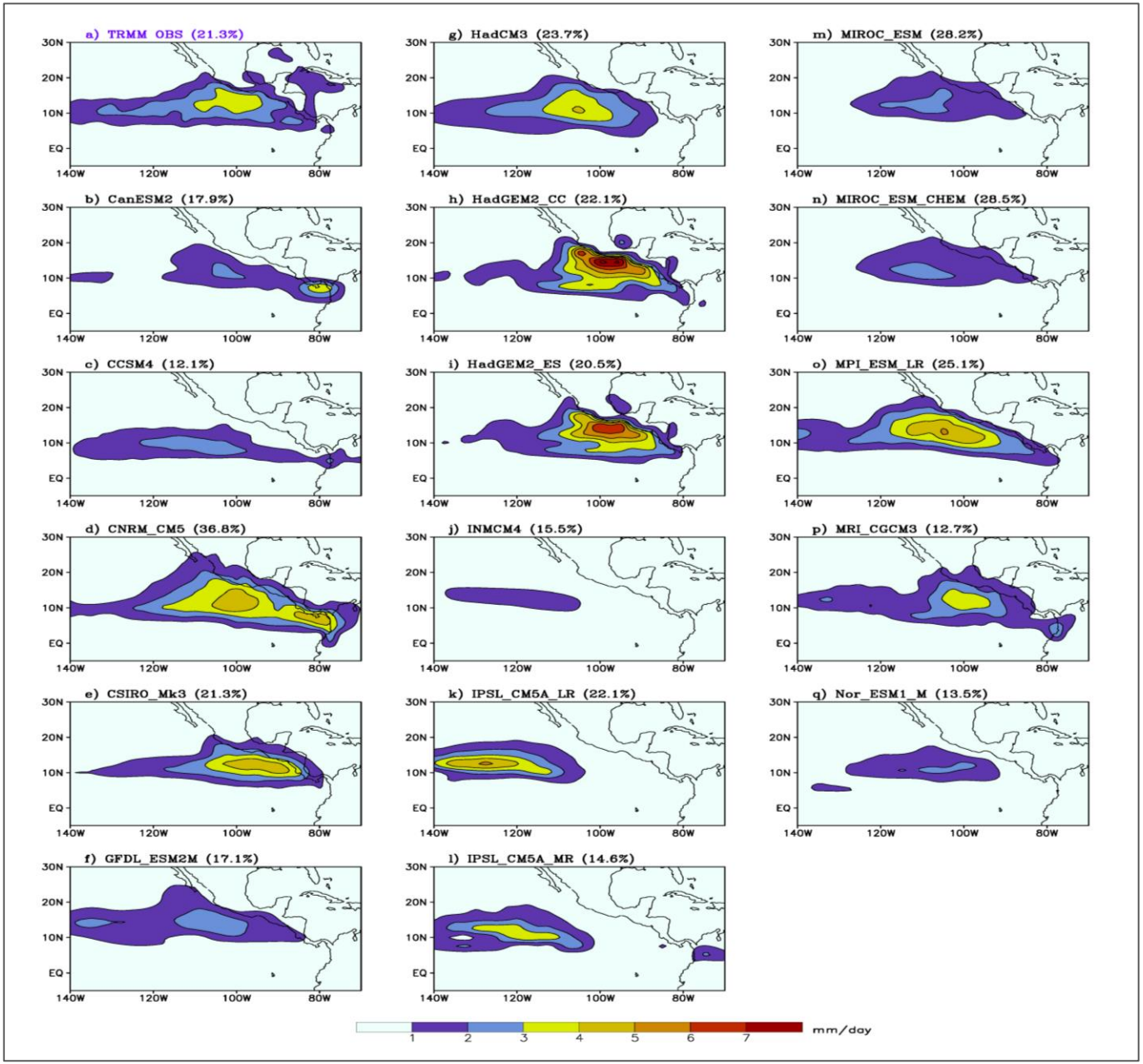
$\boldsymbol{u_j(t)}$ (j – spatial position; t – time) ⟶ TRMM Rainfall

$\boldsymbol{U_j(t) = u_j(t) + i\,\hat{u}_j(t)}$

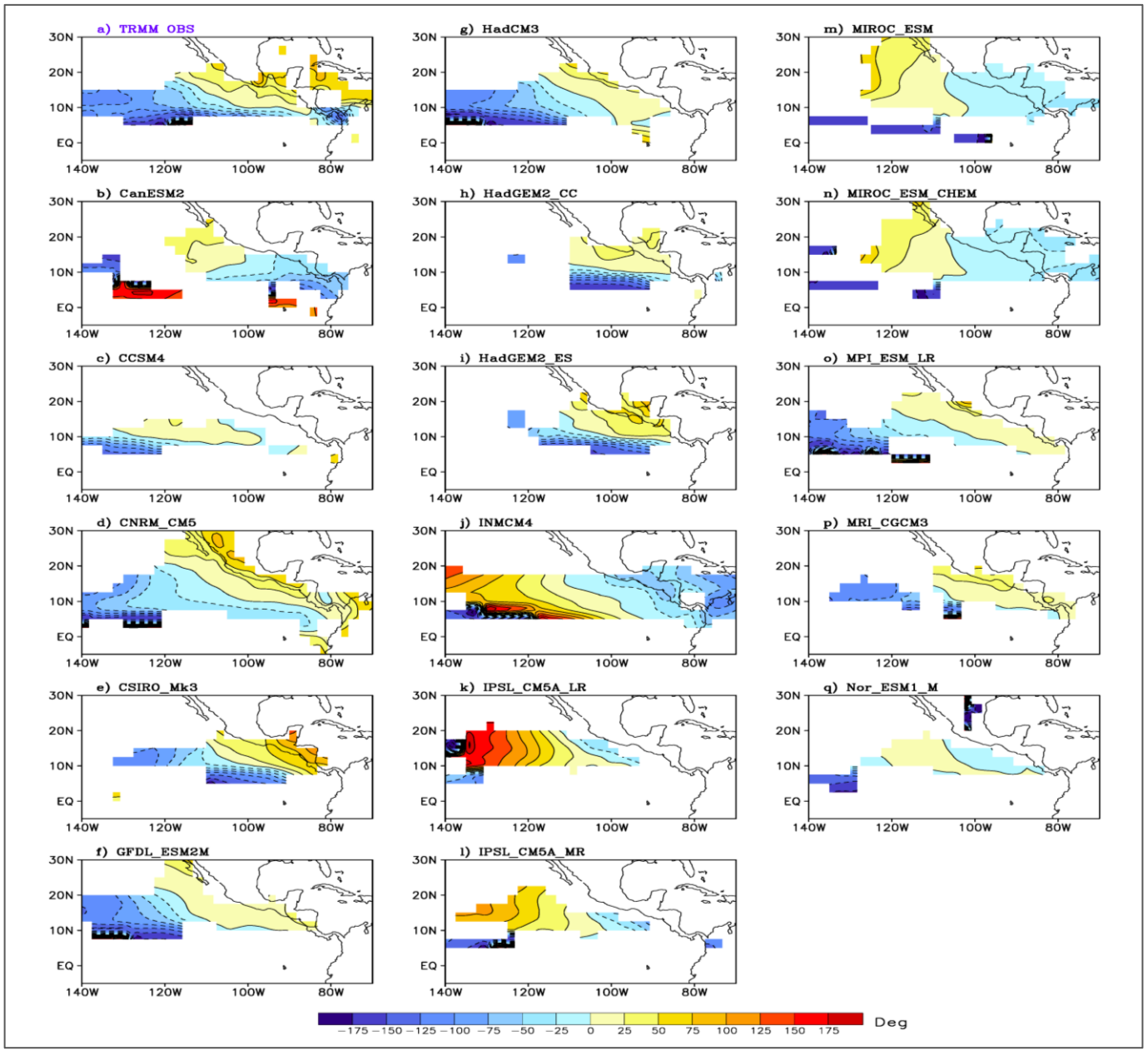
$\hat{u}_j(t)$ -- quadrature function / Hilbert transform of $u_j(t)$



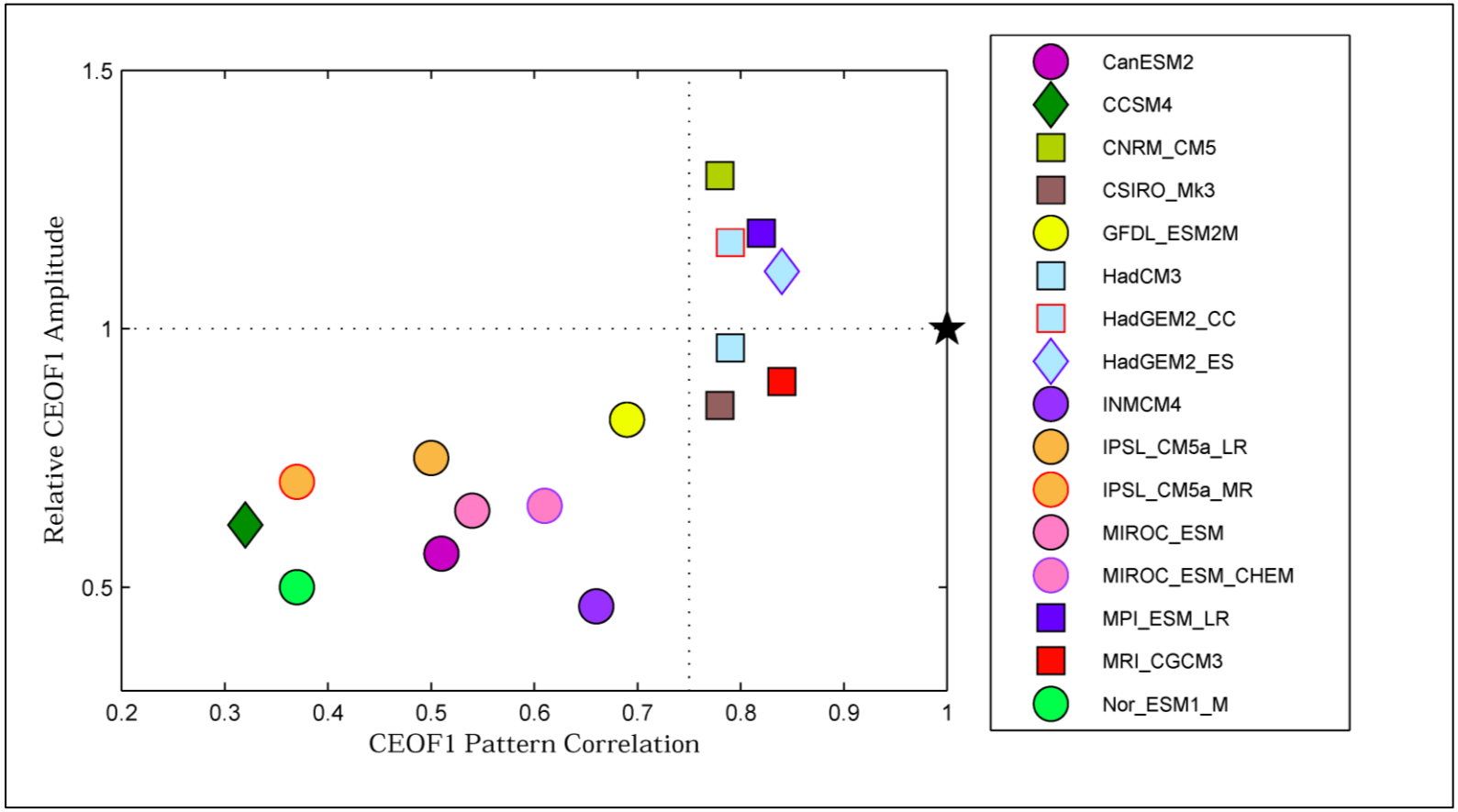
Spatial Pattern of $CEOF_1$ Amplitude



Spatial Pattern of $CEOF_1$ Phase

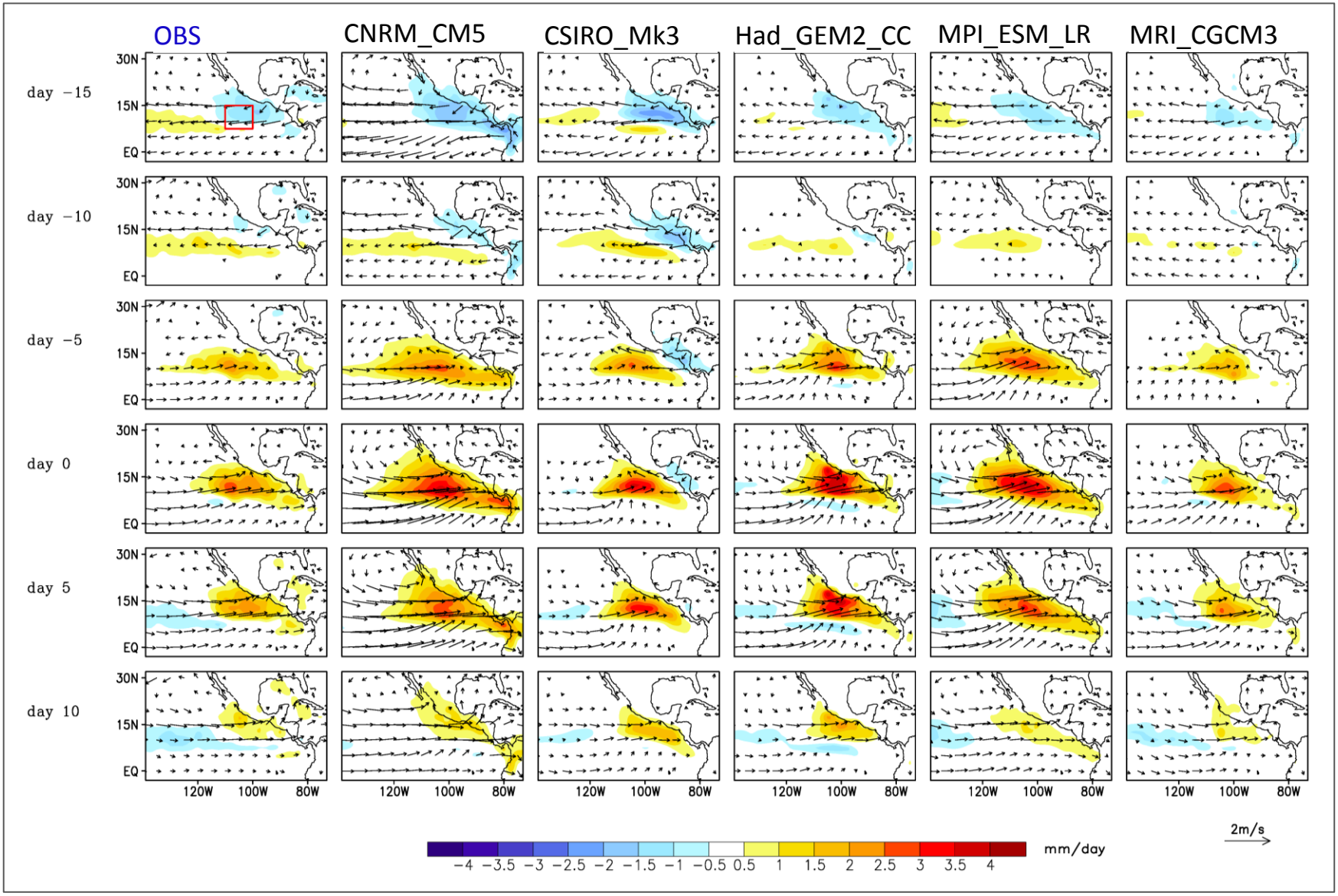


GCM skill for $CEOF_1$ Amplitude and Pattern

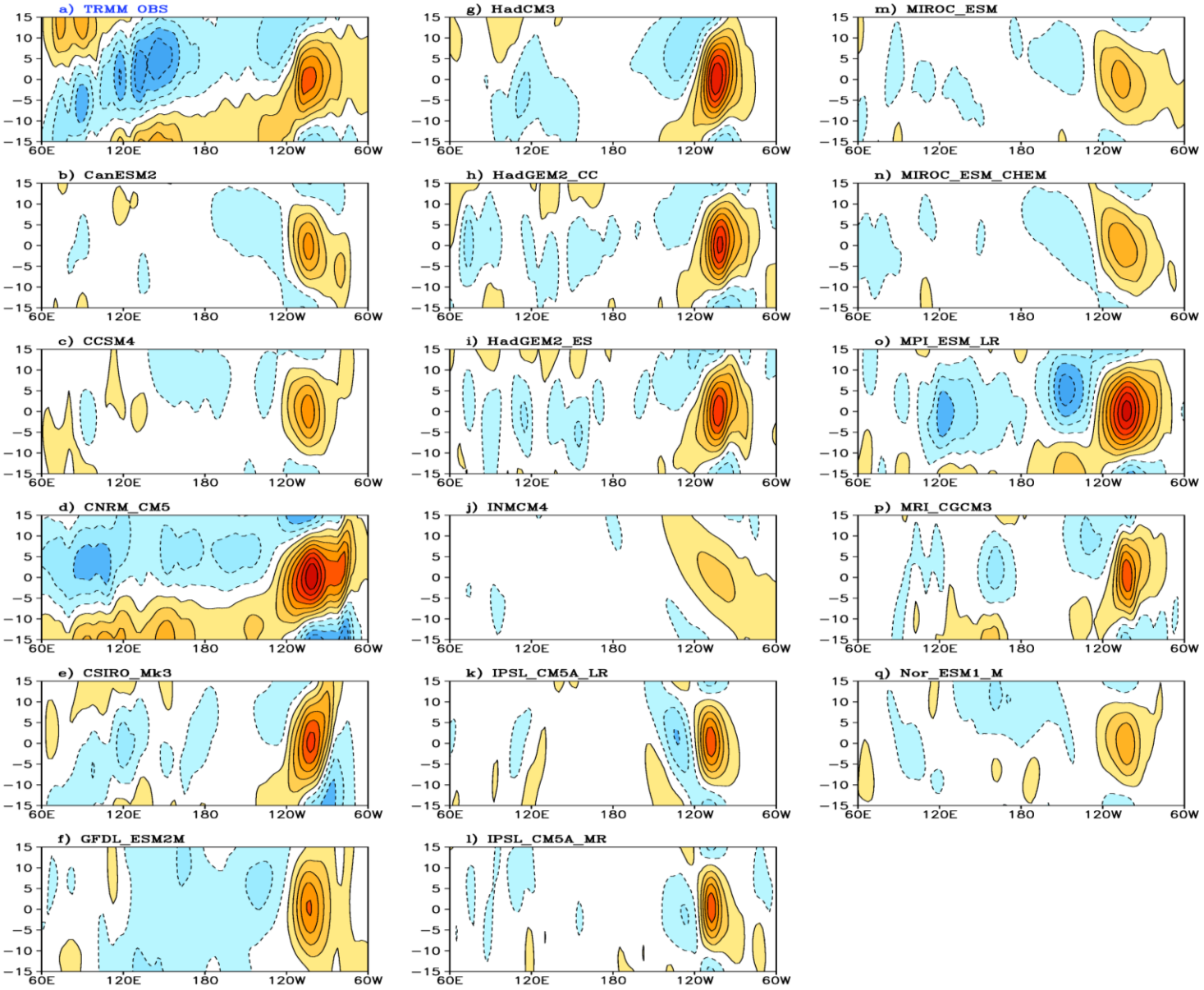


(140-80°W; 5°N-25°N)

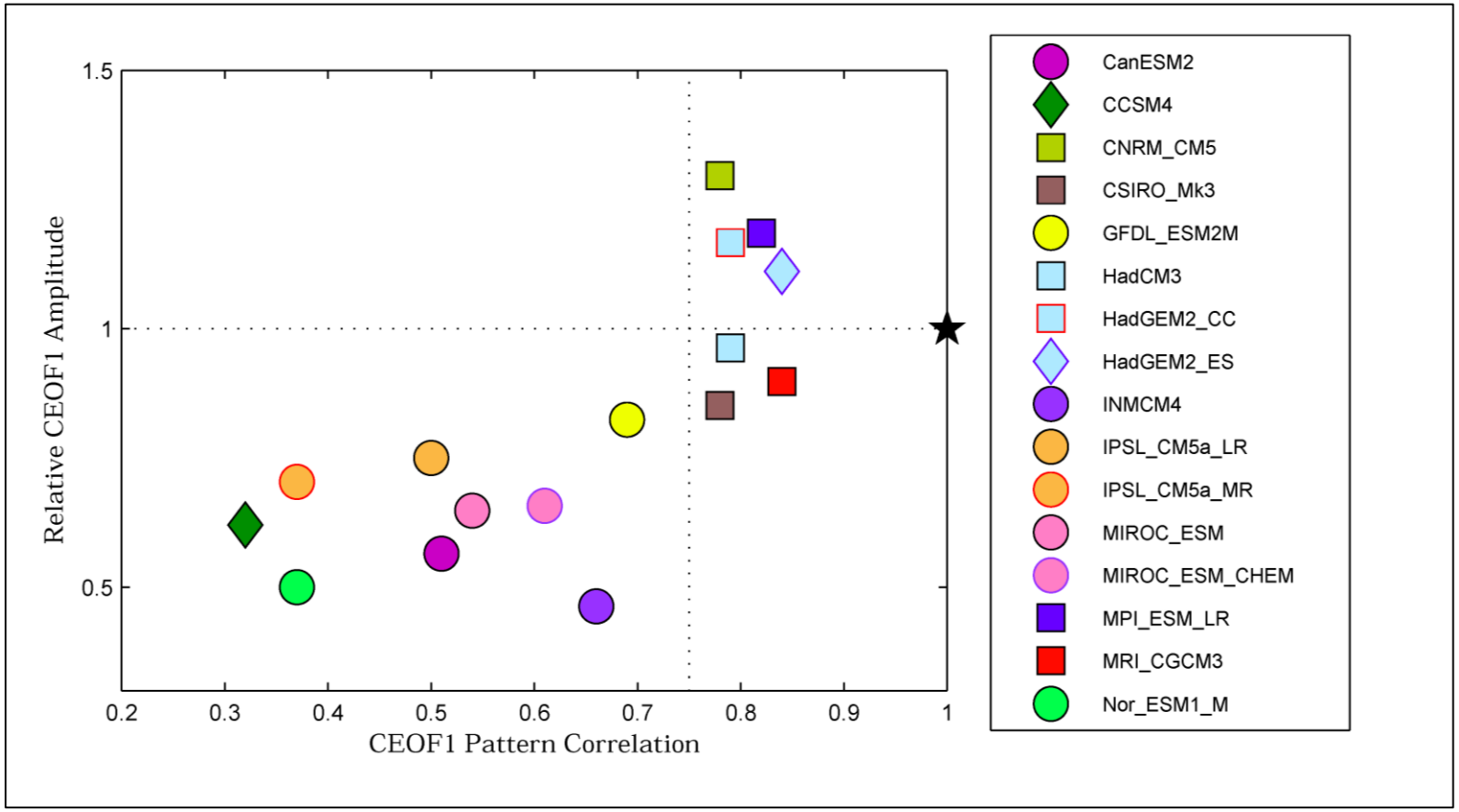
Evolution of Rainfall & 850mb winds of the leading ENP ISV mode



Eastward Propagation Associated with the ENP ISV



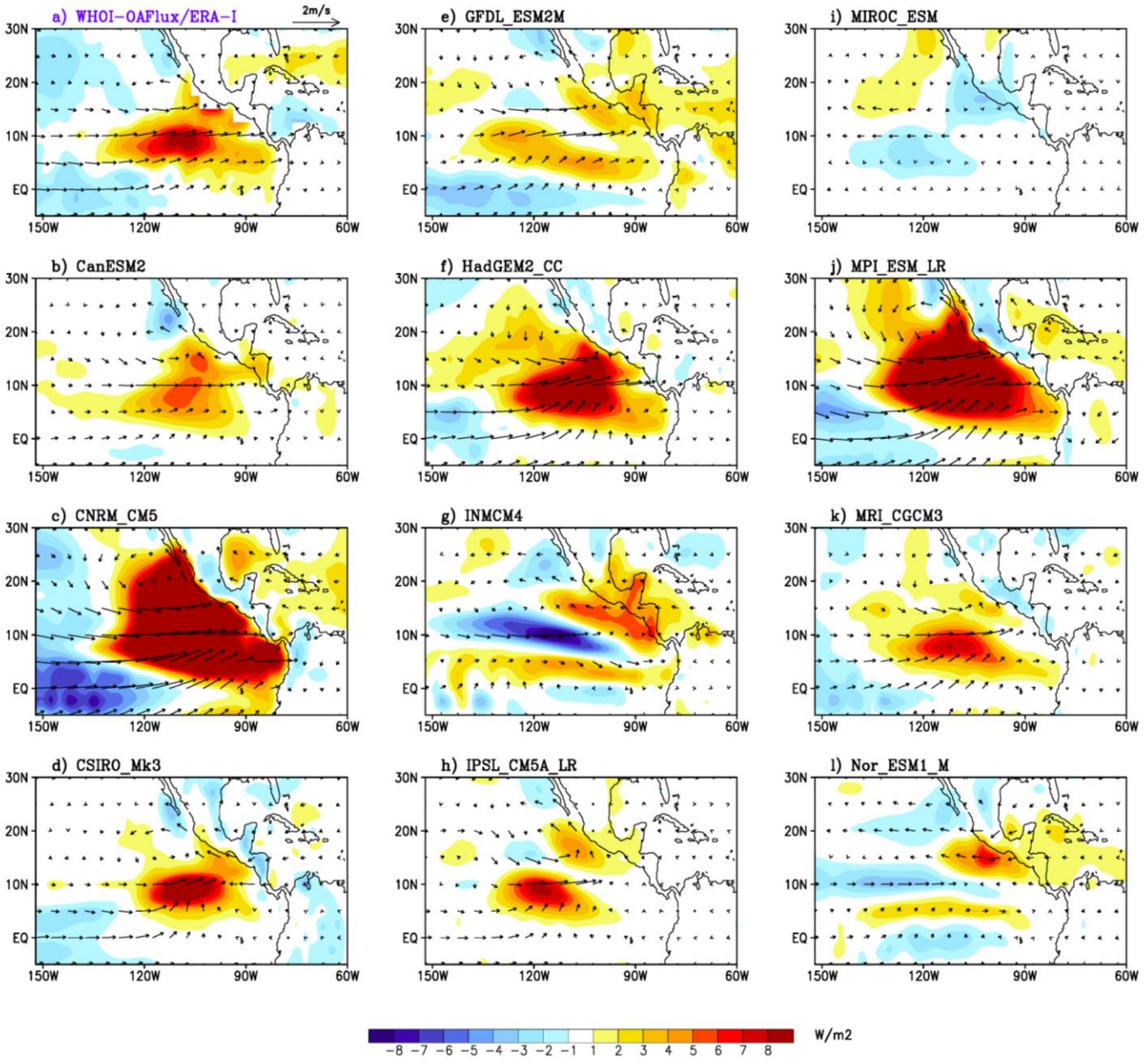
GCM skill for $CEOF_1$ Amplitude and Pattern



Westerly or weak easterly mean flow (< 1.5m/s)

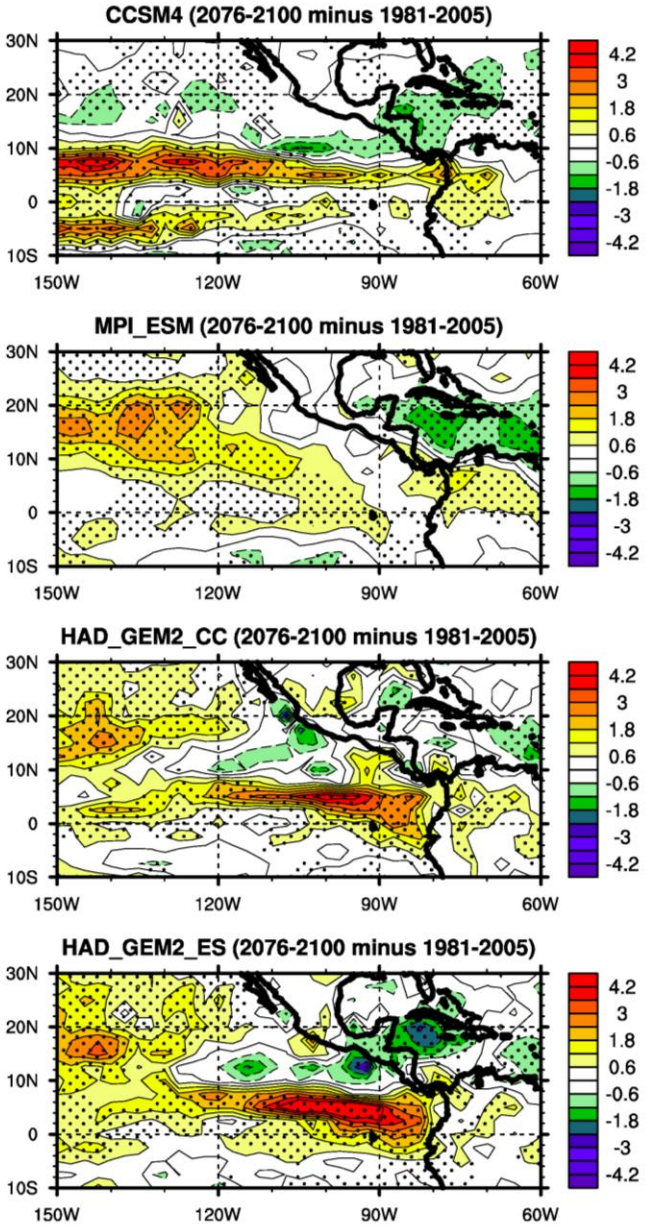
Strong easterly mean flow (> 4m/s)

Surface latent heat flux & 850mb winds at day 0

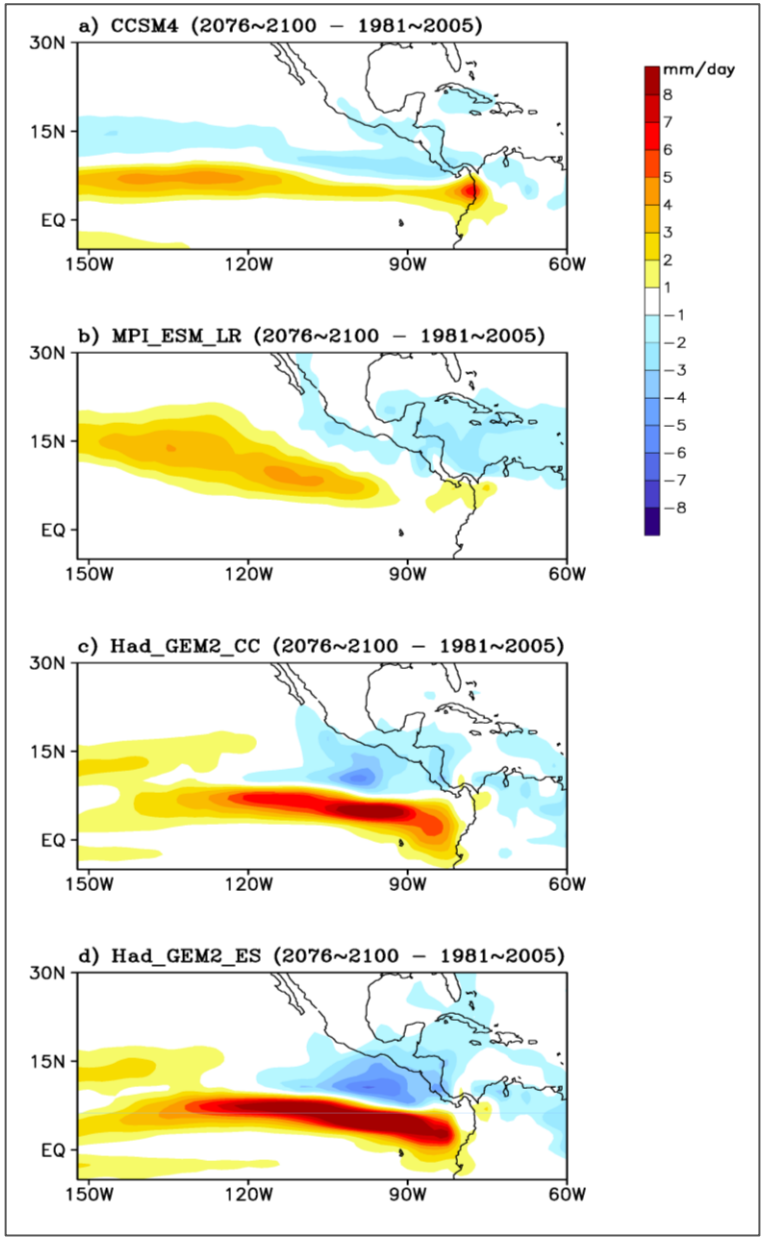


III. ENP ISV in future climate

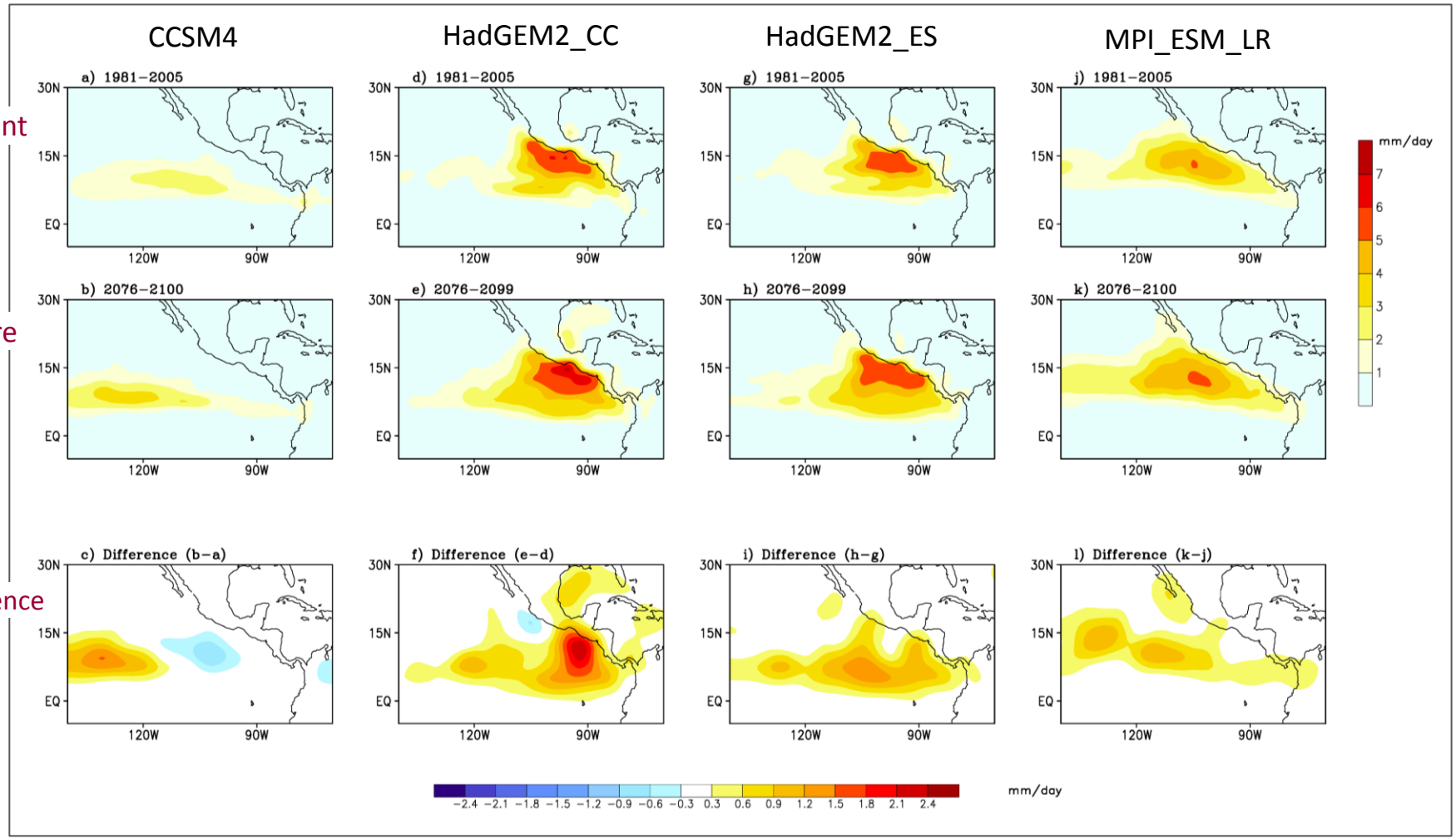
Precip Standard Deviation (Difference)



Changes in Summer Mean Rainfall



Spatial Pattern of $CEOF_1$ Amplitude in future climate



IV. Summary

- Among the sixteen CMIP5 GCMs examined in this study, only seven GCMs capture the spatial pattern of the leading ENP ISV mode relatively well, although even these several GCMs exhibit biases in simulating ISV amplitude.

- Analyses indicate that model fidelity in representing ENP ISV is closely associated with ability to simulate a realistic summer mean state. The presence of westerly or weak mean easterly winds over the ENP warm pool region could be conducive for more realistic simulations of the ISV.

- Analyses based on multi-model simulations suggest that the ISV could be sustained over the ENP basin without the forcing from the eastward propagating MJO over the Indian Ocean / western Pacific.

Reference:

Jiang, X., E. Maloney, J.-L. Li, and D. E. Waliser, 2012: Simulations of the Eastern Pacific Intraseasonal Variability in CMIP5 GCMs, *J. Climate,* accepted pending revisions.

Thank you !